EL369520919

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PTO/SB/05 (4/98)
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Patent and Trademark Office U.S. DEPARTMENT OF COMMERCE

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	MI22-1172
First Inventor or Application Identifier	D.G. Custer et al.
Title	Polishing Systems, Methods of Polishing etc.
Express Mail Label No.	EL369520919US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents

ADDRESS TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231

1. [X] * Fee Transmittal Form (e.g., PTO/SB/17) (Submit an original and a duplicate for fee processing)
2. [X] Specification [Total Pages 24] (preferred arrangement set forth below)
   - Descriptive title of the Invention Inc. Title Pg.
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings (if filed)
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) (35 U.S.C. 113) [Total Sheets 2]
4. Oath or Declaration [Total Pages 3]
   a. [ ] Newly executed (original or copy)
   b. [X] Copy from a prior application (37 C.F.R. § 1.63(d)) (for continuation/divisional with Box 16 completed)
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

*** NOTE FOR ITEMS 1 & 13 IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).**

5. [ ] Microfiche Computer Program (Appendix)
6. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. [ ] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement (when there is an assignee) [ ] Power of Attorney
9. [ ] English Translation Document (if applicable)
10. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [X] Preliminary Amendment
12. [X] Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
13. [ ] * Small Entity Statement(s) (PTO/SB/09-12) [ ] Statement filed in prior application Status still proper and desired
14. [ ] Certified Copy of Priority Document(s) (if foreign priority is claimed)
15. [X] Other: Check

16. **If a CONTINUING APPLICATION,** check appropriate box, and supply the requisite information below and in a preliminary amendment:
[ ] Continuation [X] Divisional [ ] Continuation-in-part (CIP) of prior application No: 08 / 984,730
Prior application information: Examiner L. Wilson Group / Art Unit: 3723

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

[X] Customer Number or Bar Code Label 021567 (Insert Customer No. or Attach bar code label here) or [X] Correspondence address below

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Country		Telephone		Fax	

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Signature	[signature]	Date	4/22/99

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

priority Application Serial No. 08/984,730
priority Filing Date .... December 4, 1997
Inventor .... D.G. Custer et al.
Assignee .... Micron Technology, Inc.
priority Group Art Unit 3723
priority Examiner .... L. Wilson
Attorney's Docket No. MI22-1172
Title: Polishing Systems, Methods Of Polishing Substrates, and Methods Of Preparing Liquids For Semiconductor Fabrication Processes

PRELIMINARY AMENDMENT

To: Assistant Commissioner for Patents
Washington, D.C. 20231

From: David G. Latwesen (Tel. 509-624-4276; Fax 509-838-3424)
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AMENDMENTS

In the Specification

At p. 1, before the "Technical Field" section, insert

--**RELATED PATENT DATA**

This patent resulted from a divisional application of U.S. Patent Application Serial No. 08/984,730, which was filed on December 4, 1997.--.

Amended Claims

Cancel claims 6-38.

REMARKS

Claims 6-38 are canceled, leaving claims 1-5 pending in the application. Applicant requests substantive examination of such pending claims.

Respectfully submitted,

Dated: 4/22/99

By: [signature]

David G. Latwesen, Ph.D.
Reg. No. 38,533

EM156304031
EL369520919

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR LETTERS PATENT

* * * * *

POLISHING SYSTEMS, METHODS OF POLISHING SUBSTRATES, AND METHODS OF PREPARING LIQUIDS FOR SEMICONDUCTOR FABRICATION PROCESSES

* * * * *

INVENTORS

Dan G. Custer
Aaron Trent Ward
Shawn M. Lewis

ATTORNEY'S DOCKET NO. MI22-775

POLISHING SYSTEMS, METHODS OF POLISHING SUBSTRATES, AND METHODS OF CLEANING POLISHING SLURRY FROM SUBSTRATE SURFACES

TECHNICAL FIELD

The invention pertains to methods and apparatuses for increasing dissolved gas concentrations in liquids and to methods of providing liquids for semiconductive wafer fabrication processes, such as polishing systems. The invention also pertains to methods of cleaning polishing slurry from semiconductive substrate surfaces.

BACKGROUND OF THE INVENTION

In many semiconductive material fabrication processes it is desirable to utilize deionized and degassed water. The deionization is used to remove elemental contaminants from the water and can increase a resistance of the water to from about 200 kohms to about 1800 kohms.

The degassification is used to remove carbon dioxide from the water. Carbon dioxide can influence a pH of the water. The degassification also, however, removes other gasses from water besides carbon dioxide. Such other gasses can include, for example, oxygen and nitrogen. An example unit for degassifying water is a Liquicell unit (available from Hoechst Celanese Corp. at 13800 South Lake Drive, Charlotte, N.C. 28273), which removes gasses via a gas permeable membrane.

The deionization and degassification of water is typically done on a system-wide scale in a semiconductive material fabrication plant. Accordingly, all water supplied to the various fabrication units of the plant is degassed and deionized.

SUMMARY OF THE INVENTION

The invention encompasses methods and apparatuses for increasing dissolved gas concentrations in liquids, and methods of providing liquids for semiconductive wafer fabrication processes, such as polishing systems. The invention also encompasses polishing systems for polishing semiconductive material substrates, and methods of cleaning polishing slurry from semiconductive substrate surfaces.

In one aspect, the invention encompasses a method of preparing a liquid for a semiconductor fabrication process. A liquid is provided, and a gas is injected into the liquid to increase a total dissolved gas concentration in the liquid.

In another aspect, the invention encompasses a method of cleaning a polishing slurry from a substrate surface. A substrate surface is provided, and a polishing slurry is provided in contact with the substrate surface. A liquid is provided. A gas is injected into the liquid to increase a total dissolved gas concentration in the liquid. After the injecting, the liquid is provided against the substrate surface to displace the polishing slurry from the substrate surface.

In yet another aspect, the invention encompasses a method of polishing a substrate surface. A polishing slurry is provided between a substrate surface and a polishing pad. The substrate surface is polished with the polishing slurry. The polishing slurry is removed from the substrate surface. The removing comprises the following. A liquid is provided. A first gas is removed from the liquid to reduce a total dissolved gas concentration in the liquid. After removing the first gas, a second gas is dissolved in the liquid to increase the total dissolved gas concentration in the liquid. After dissolving the second gas, the liquid is provided between the substrate surface and the polishing pad to displace the polishing slurry from the substrate surface.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are described below with reference to the following accompanying drawings.

Fig. 1 is a fragmentary, diagrammatic cross-sectional view of a polishing apparatus for polishing a semiconductive wafer.

Fig. 2 is a top view of the Fig. 1 apparatus.

Fig. 3 is a diagrammatic and schematic cross-sectional view of a gassification apparatus of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This disclosure of the invention is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

In accordance with the present invention it is recognized that liquids utilized for various wafer fabrication processes will preferably have at least a threshold dissolved gas concentration. It has been discovered that if water utilized in polishing processes has a dissolved gas concentration below a threshold, wafers will slip out of a polishing apparatus at a significantly higher frequency than if the dissolved gas concentration is above the threshold. It is also expected that if water utilized in a semiconductor wafer etch or polish processes has a dissolved gas concentration below a threshold, the water will become a better solvent for various etchant or polishing compounds than if the dissolved gas concentration is above the threshold. The better solvent properties of the water can alter an etch or polish rate and lead to defects in the etched or polished wafer. Such defects can include domed regions, inclusions, and cavities. Accordingly, the present invention encompasses methods of providing dissolved gasses in water and other liquids.

An example polishing process is described with reference to a polishing apparatus 10 in Figs. 1 and 2. Polishing apparatus 10 can, for example, be an apparatus configured to accomplish chemical-

mechanical polishing. Apparatus 10 comprises a polishing pad 12 and semiconductive wafer holders 14 and 16.

Wafer holders 14 and 16 hold a pair of semiconductive wafers 18 and 20 adjacent a surface of the polishing pad 12. Wafer holders 14 and 16 comprise sidewalls 22 and 24, respectively. Generally, semiconductive wafers 18 and 20 are circular in shape, and sidewalls 22 and 24 are circular and ring-shaped to completely encircle wafers 18 and 20.

In operation, a polishing slurry is provided between semiconductive wafers 18 and 20, and polishing pad 12. The polishing slurry can comprise, for example, ILD 1300 or MSW 1300 manufactured by Rodel, Inc. of Delaware. After the slurry is provided, wafer holders 14 and 16 are utilized to move wafers 18 and 20 relative to polishing pad 12 to polish surfaces of wafers 18 and 20 with the slurry.

As shown in Fig. 2, wafer holders 16 and 18 are preferably configured to move semiconductive wafers 18 and 20 in a number of directions relative to polishing pad 12 during a polishing process. Such directions are illustrated by axes "A," "B," "C," "D," and "E." Axes A, B, and E are rotational axes, and axes C and D are translational axes. The many varied rotations and translations illustrated in Fig. 2 enable wafers 18 and 20 to be polished quickly and uniformly.

Polishing apparatus 10 comprises a pair of nozzles 27. After a surface of wafers 18 and 20 is polished, a liquid is introduced through nozzles 27 and onto polishing pad 12 to displace the polishing slurry

from between wafers 18 and 20 and polishing pad 12. Wafers 18 and 20 typically are moved relative to polishing pad 12 as the liquid is provided onto polishing pad 12. The liquid preferably comprises deionized water, and more preferably consists essentially of deionized water having some dissolved gas therein. In accordance with the present invention, it has been discovered that if the liquid comprises too low of a dissolved gas concentration, excess friction will develop between wafers 18 and 20 and polishing pad 12. Such excess friction can result in wafers 18 and 20 being disastrously expelled from wafer holders 14 and 16, a so-called "slip-out" of the wafers.

A method for determining total dissolved gas in water is to measure the concentration of dissolved oxygen. As discussed in the Background section of this disclosure, degassification procedures are generally not selective for particular dissolved gasses and lower all dissolved gasses in a liquid. A dissolved oxygen concentration can be particularly conveniently measured by methods known to persons of ordinary skill in the art. It is therefore expedient to quantitate a dissolved oxygen concentration and to use this as an indicator of a total dissolved gas concentration in a source of water. It has been found experimentally that if the dissolved oxygen concentration in a source of water is above about 150 parts per billion (ppb), preferably above about 190 ppb, and more preferably above about 200 ppb, slip-out of wafers can be avoided. However, when the dissolved oxygen concentration falls to below 150 ppb slip-out becomes unacceptably

frequent. Often, slip-out becomes unacceptably frequent if the dissolved oxygen concentration falls to below 200 ppb. Currently utilized degassification procedures will reduce dissolved oxygen concentrations to about 4 ppb, which is too low for many polishing processes. Accordingly, it is desirable to regassify water prior to utilization in polishing processes.

The gas provided in a liquid during a regassification procedure can have a composition different from the gas removed from the liquid during a degassification procedure. The gas removed from the liquid during the degassification process is a first gas which will generally have a composition similar to that of the atmosphere. The gas provided back into the liquid during a regassification is a second gas which is preferably a relatively cheap and non-reactive gas, such as argon or nitrogen. The second gas is preferably provided to a concentration of at least 200 ppb, preferably of from about 450 ppb to about 550 ppb, and more preferably of at least about 500 ppb. Such concentration of second gas has been found experimentally to convert a degassified liquid having 4 ppb of dissolved oxygen to a liquid which will significantly reduce slip-out of wafers. An exemplary upper limit of the second gas which can be added to deionized water is about 7 parts per million (ppm), as this is about the maximum amount of dissolved gas that deionized water can retain at room temperature and atmospheric pressure.

A preferred method for regassifying a liquid is described with reference to a regassification apparatus 50 in Fig. 3. Apparatus 50 comprises a pipe 52 through which a liquid flows from a source 54 to a polishing apparatus 56. Pipe 52 can comprise, for example, a nominal half-inch inner diameter. Pipe 52 comprises a tee 58 wherein a gas is injected with the liquid to increase a dissolved gas concentration in the liquid. The gas flows from a source 60, through a pressure regulator 62, a flowmeter 64, a pressure/flow switch 66, a check valve 68, and a gas dispersion unit 70 to inject with liquid in tee 58. Source 60 preferably comprises the gas stored at pressure greater than atmospheric pressure.

Gas dispersion unit 70 can comprise, for example, a sintered filter. A sintered filter 70 can comprise a number of materials and constructions known to persons of skill in the art. For example, filter 70 can comprise a stainless steel filter having about 0.5 micron pores. Filter 70 comprises a nipple 72 extending beneath tee 58 and having, for example, about a one-quarter inch diameter.

In an example process wherein nitrogen is flowed into water, a pressure of the nitrogen will preferably be maintained at about 100 pounds per square inch gauge (psig), and a flow of the nitrogen will preferably be maintained at about 750 cubic centimeters per minute (ccpm). Also, check valve 68 will preferably be set to a pressure of 2 psi. The water will preferably be flowed through pipe 52 at a rate of

from about 2.5 gallons per minute to about 4 gallons per minute, and a pressure of 45-50 psig.

Pipe 52 defines a tube through which fluid flows. The liquid from source 54 and gas from source 60 meet within such tube. By having the liquid confined in a tube as it is injected with gas, a controlled pressure of liquid and gas can be maintained to substantially ensure that the gas dissolves within the liquid.

The apparatus of Fig. 3 represents a preferred method for increasing a total dissolved gas concentration in a liquid. Another method for increasing a total dissolved gas concentration in a liquid is to introduce a flush gas in a gas-permeable-membrane-based degassification procedure. An example gas-permeable-membrane-based degassification procedure is a Liquicell procedure. The flush gas is provided at the membrane during degassification and helps to remove inherent gasses from a liquid as the liquid is degassified. Some of the flush gas will remain in the liquid after the liquid passes through the degassification apparatus. For instance, if nitrogen is utilized as a flush gas in a degassification membrane procedure, the nitrogen will essentially replace at least some of the carbon dioxide and other gasses originally present in the liquid. Thus, the water is both degassed and regassified in a common step.

Persons of ordinary skill in the art will recognize that a dissolved nitrogen concentration in the "degassed" water can be adjusted by adjusting a flow of the nitrogen flush gas. If the water is to be

utilized in a polishing process of the present invention, the nitrogen gas flow rate will preferably be adjusted to result in nitrogen being present in the water at concentrations in excess of 200 ppb, and more preferably at concentrations in a range of from 450 ppb to about 550 ppb.

The methods discussed above for regassifying liquids have been described for applications in which the regassified liquids are utilized to displace slurries from polishing apparatuses. It is to be understood that such regassified liquids can also be utilized for other semiconductive wafer fabrication processes. For instance, the regassified liquids could be utilized for cleaning semiconductive wafers prior to processing steps. For example, semiconductive wafers are frequently washed with deionized water prior to polishing of the wafers in a polishing apparatus. Such deionized water can be regassified water produced in accordance with methods of the present invention.

In compliance with the statute, the invention has been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the invention is not limited to the specific features shown and described, since the means herein disclosed comprise preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

CLAIMS:

1. A method of preparing a liquid for a semiconductor fabrication process comprising:

providing a liquid; and

injecting a gas into the liquid to increase a total dissolved gas concentration in the liquid to greater than or equal to 200 ppb.

2. The method of claim 1 wherein the semiconductor fabrication process is a polishing process.

3. The method of claim 1 wherein the semiconductor fabrication process is a polishing process and the liquid comprises water.

4. The method of claim 1 wherein the semiconductor fabrication process is an etch process.

5. The method of claim 1 wherein the semiconductor fabrication process is a wet etch process and the liquid comprises water.

6. A semiconductor wafer fabrication process sequentially comprising:

degassifying a liquid to a dissolved oxygen concentration of less than 200 ppb;

regassifying the liquid with a regassifying gas to a regassifying gas concentration of greater than 200 ppb; and

applying the liquid onto a surface of a semiconductor wafer.

7. The process of claim 6 wherein the applying comprises providing the liquid intermediate a moving polishing and a semiconductor wafer against which moving polishing pad is received.

8. The process of claim 6 wherein the regassifying comprises injecting gas under pressure into the liquid.

9. The process of claim 6 wherein the regassifying gas does not include oxygen.

10. The process of claim 6 wherein the regassifying comprises regassifying to a regassifying gas concentration of greater than 500 ppb.

11. A method of cleaning a polishing slurry from a substrate surface comprising:

providing a substrate surface having a polishing slurry in contact therewith;

providing a liquid;

injecting a gas into the liquid to increase a total dissolved gas concentration in the liquid; and

providing the liquid with the increased total dissolved gas concentration against the substrate surface to displace the polishing slurry from the substrate surface.

12. The method of claim 11 wherein the liquid comprises deionized water.

13. The method of claim 11 wherein the liquid consists essentially of deionized water having some gas dissolved therein.

14. The method of claim 11 wherein the liquid consists essentially of deionized water having some gas dissolved therein, and wherein the substrate is a semiconductive wafer.

15. The method of claim 11 wherein the injecting the gas into the liquid comprises flowing pressurized gas through a gas dispersion unit and into the liquid.

16. The method of claim 11 further comprising:

before the injecting, removing dissolved gas from the liquid to reduce a total dissolved gas concentration within the liquid.

17. A method of polishing a substrate surface comprising:

providing a polishing slurry between a substrate surface and a polishing pad;

polishing the substrate surface with the polishing slurry; and

removing the polishing slurry from the substrate surface, the removing comprising:

providing a liquid;

injecting a gas into the liquid to increase a total dissolved gas concentration in the liquid; and

providing the liquid with the increased total dissolved gas concentration between the substrate surface and the polishing pad to displace the polishing slurry from the substrate surface.

18. The method of claim 17 wherein the polishing pad spins relative to the substrate surface as the liquid is provided between the substrate surface and the polishing pad.

19. The method of claim 17 wherein the polishing comprises chemical-mechanical polishing.

20. The method of claim 17 wherein the injecting the gas into the liquid comprises flowing pressurized gas through a gas dispersion unit and into the liquid.

21. The method of claim 17 wherein the liquid comprises deionized water.

22. The method of claim 17 wherein the liquid consists essentially of deionized water having some gas dissolved therein.

23. A method of polishing a substrate surface comprising:

providing a polishing slurry between a substrate surface and a polishing pad;

polishing the substrate surface with the polishing slurry; and

removing the polishing slurry from the substrate surface, the removing comprising:

providing a liquid;

removing a first gas from the liquid to reduce a total dissolved gas concentration in the liquid;

after the removing the first gas, dissolving a second gas in the liquid to increase the total dissolved gas concentration in the liquid; and

after the dissolving, providing the liquid between the substrate surface and the polishing pad to displace the polishing slurry from the substrate surface and thereby remove the polishing slurry from the substrate surface.

24. The method of claim 23 wherein the substrate is a semiconductive wafer.

25. The method of claim 23 wherein the polishing comprises chemical-mechanical polishing.

26. The method of claim 23 wherein the first gas comprises a different composition than the second gas.

27. The method of claim 23 wherein the removing reduces a total dissolved oxygen concentration in the liquid to below 200 ppb, and wherein the dissolving comprises dissolving nitrogen gas in the liquid to a concentration of at least 500 ppb.

28. The method of claim 23 wherein the liquid comprises deionized water.

29. The method of claim 23 wherein the liquid consists essentially of deionized water having some gas dissolved therein.

30. The method of claim 23 wherein the dissolving comprises flowing pressurized second gas through a gas dispersion unit and into the liquid.

31. The method of claim 23 wherein the dissolving comprises flowing pressurized second gas through a gas dispersion unit and into the liquid as the liquid flows past the gas dispersion unit, the liquid being contained in a tube at a point at which the liquid meets the second gas coming from the gas dispersion unit.

32. The method of claim 23 further comprising:

before providing the polishing slurry between the substrate surface and the polishing pad, rinsing the substrate surface with the liquid.

33. A chemical-mechanical polishing process comprising:

providing a semiconductive wafer substrate proximate a polishing pad, the semiconductive wafer substrate comprising a substrate surface;

providing a polishing slurry between the substrate surface and the polishing pad;

chemical-mechanical polishing the substrate surface with the polishing slurry, the chemical-mechanical polishing comprising moving the substrate surface relative to the polishing pad; and

removing the polishing slurry from the substrate surface, the removing comprising:

providing a deionized and degassed water, the deionized and degassed water having a resistance of greater than 200 kohms and a dissolved oxygen concentration of less than 200 ppb;

injecting a gas into the water to a concentration of at least 450 ppb, the injecting comprising providing a pressurized source of the gas and flowing the pressurized gas through a gas dispersion unit and into the water at a location where the water is contained within a pipe; and

after the injecting, providing the water between the substrate surface and the polishing pad to displace the polishing slurry from between the substrate surface and the polishing pad, and to thereby remove the polishing slurry from the substrate surface.

34. The process of claim 33 further comprising cleaning the substrate surface before providing the polishing slurry, and wherein the substrate surface is cleaned with the water after the gas has been injected into the water.

35. The process of claim 33 wherein the gas does not comprise oxygen.

36. A polishing system comprising:

a wafer holder for holding a semiconductive wafer;

a polishing pad for polishing a surface of the wafer when a polishing slurry is provided between the polishing pad and the surface of the wafer, the wafer holder being movable relative to the polishing pad;

a source of degassed water, the degassed water having less than 200 ppb of total dissolved gasses and being provided to flush polishing slurry from between the polishing pad and the surface of the wafer after a polishing the surface of the wafer with the polishing pad;

a pipe through which the degassed water flows;

a source of gas in fluid communication with the pipe through which the degassed water flows;

a gas dispersion unit between the source of gas and the pipe through which the degassed water flows; and

wherein the gas dispersion unit and the pipe are configured so that a degassed water flowing through the pipe is contained within the pipe at a location wherein the degassed water meets a gas flowing from the gas dispersion unit.

37. The system of claim 36 further comprising a tee where the gas flowing from the gas dispersion unit meets the degassed water flowing through the pipe.

38. The system of claim 36 wherein the gas dispersion unit comprises a sintered filter.

ABSTRACT OF THE DISCLOSURE

The invention encompasses polishing systems for polishing semiconductive material substrates, and encompasses methods of cleaning polishing slurry from semiconductive substrate surfaces. In one aspect, the invention includes a method of cleaning a polishing slurry from a substrate surface comprising: a) providing a substrate surface having a polishing slurry in contact therewith; b) providing a liquid; c) injecting a gas into the liquid to increase a total dissolved gas concentration in the liquid; and d) after the injecting, providing the liquid against the substrate surface to displace the polishing slurry from the substrate surface. In another aspect the invention includes a method of polishing a substrate surface comprising: a) providing a polishing slurry between a substrate surface and a polishing pad; b) polishing the substrate surface with the polishing slurry; and c) removing the polishing slurry from the substrate surface, the removing comprising: i) providing a liquid; ii) removing a first gas from the liquid to reduce a total dissolved gas concentration in the liquid; iii) after the removing, dissolving a second gas in the liquid to increase the total dissolved gas concentration in the liquid; iv) after the dissolving, providing the liquid between the substrate surface and the polishing pad to displace the polishing slurry from the substrate surface.

EL369520919

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Priority APPLICATION SERIAL NO. 08/984,730
Priority FILING DATE .... December 4, 1997
INVENTORSHIP .... D.G. Custer et al.
ASSIGNEE .... Micron Technology, Inc.
Priority GROUP ART UNIT 3723
Priority EXAMINER .... L. Wilson
ATTORNEY'S DOCKET NO. MI22-1172
TITLE: Polishing Systems, Methods of Polishing Substrates, and Methods of Preparing Liquids for Semiconductor Fabrication Processes

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Assistant Commissioner for Patents
Washington, D. C. 20231
Attention: Official Draftsman

SUBSTITUTE DRAWING REQUEST

Please enter the enclosed substitute drawings in the above-referenced application in place of drawings originally filed. The content of the drawings are identical to those now on file in this application.

Acknowledgment of receipt of the formal drawings and their acceptance into the file is requested.

Respectfully submitted,

Date: 4/22/99

By: [signature]

David G. Latwesen, Ph.D.
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Enclosures: 2 Sheets of Formal Drawings, Figs. 1-3.

MI22-1172

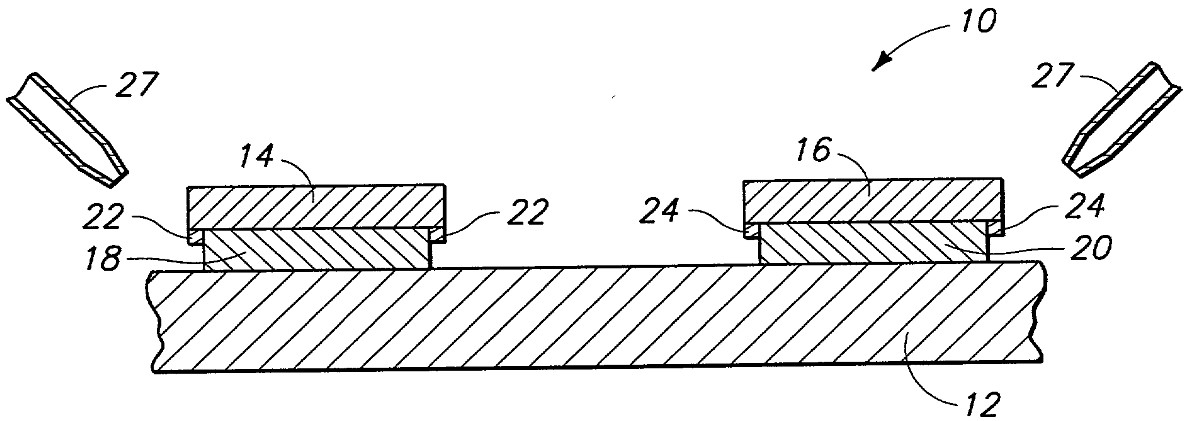

Fig 1

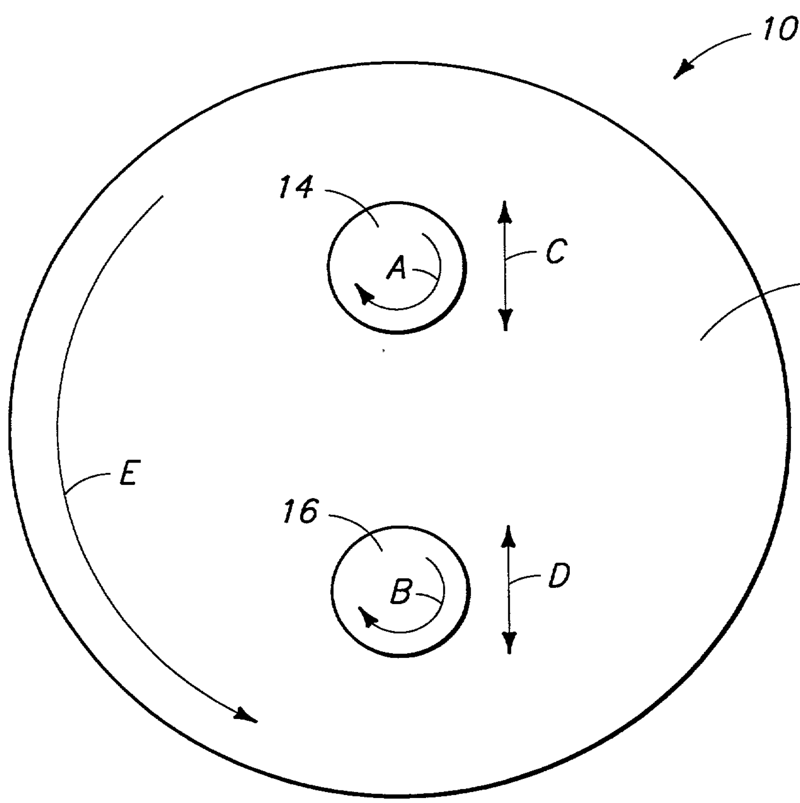

Fig 2

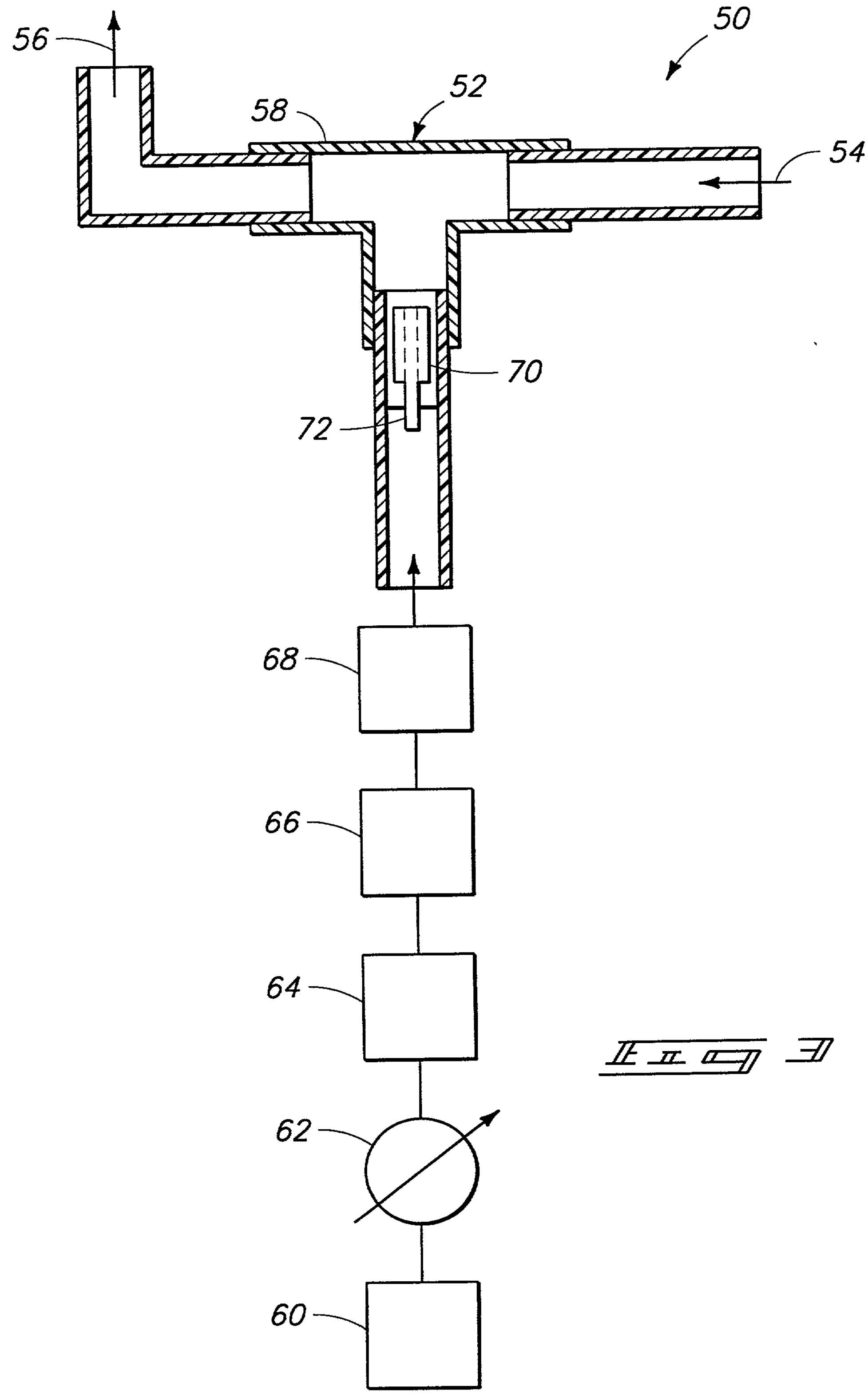

FIG. 3

DECLARATION OF JOINT INVENTORS FOR PATENT APPLICATION

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: "Polishing Systems, Methods of Polishing Substrates, and Methods of Preparing Liquids for Semiconductor Fabrication Processes," the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations §1.56.

PRIOR FOREIGN APPLICATIONS:

I hereby state that no applications for foreign patents or inventor's certificates have been filed prior to the date of execution of this declaration.

POWER OF ATTORNEY:

As a named Inventor, I hereby appoint the following attorneys and agent to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Richard J. St. John, Reg. No. 19,363; David P. Roberts, Reg. No. 23,032; Randy A. Gregory, Reg. No. 30,386; Mark S. Matkin, Reg. No. 32,268; James L. Price, Reg.

No. 27,376; Deepak Malhotra, Reg. No. 33,560; Mark W. Hendricksen, Reg. No. 32,356; David G. Latwesen, Reg. No. 38,533; George G. Grigel, Reg. No. 31,166; Keith D. Grzelak, Reg. No. 37,144; John S. Reid, Reg. No. 36,369; Lance R. Sadler, Reg. No. 38,605; James D. Shaurette, Reg. No. 39,833; Lia Pappas Dennison, Reg. No. 34,095; and Michael L. Lynch, Reg. No. 30,871.

Send correspondence to: WELLS, ST. JOHN, ROBERTS, GREGORY & MATKIN P.S., 601 W. First Avenue, Suite 1300, Spokane, WA 99204-0317. Direct telephone calls to: David G. Latwesen, Ph.D., (509) 624-4276.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statement may jeopardize the validity of the application or any patent issued therefrom.

* * * * * * * * * * *

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* * * * * * * * * * *

Full name of inventor: **Aaron Trent Ward**

Inventor's Signature: Aaron Trent Ward

Date: 12/3/97

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